Spatial and Temporal Characteristics of Paleoseismic Features in the Southern Terminus of the New Madrid Seismic Zone in Eastern Arkansas

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ABSTRACT

The University of Arkansas at Little Rock (UALR) research team is currently conducting a comprehensive geological and geophysical investigation to identify and characterize specific features related to historic or prehistoric earthquakes near the southern terminus of the New Madrid Seismic Zone in eastern Arkansas. Widespread earthquake-related features or enhanced seismicity have not been previously documented south of Parkin, AR. Recently conducted aerial and field surveys, however, reveal the existence of liquefaction features, sand blows, and a linear feature as far as south of Marianna, Arkansas. This is more than 100 kilometers from the currently active segments of the New Madrid Seismic Zone. We believe that these earthquake-related features are significant for the following reasons: (1) they are at considerable distance from present-day earthquake activity. The implication of this is that they represent either a new earthquake source region not previously recognized, or the earthquake(s) in the source region of the New Madrid Seismic Zone that generated these features must have been of very large magnitude. (2) These features appear to have large dimensions (some ~110 meters), resembling features in the immediate vicinity of the New Madrid Seismic Zone. The implication is that, wherever source region is, the ground shaking must be significantly severe in order to generate these features. (3) Detailed investigation of these features will potentially have important implications for earthquake risk mapping in the central United States. (4) They will provide important constraints on the southern terminus of the New Madrid Seismic Zone and the magnitude of the characteristic earthquake in the region.

ACOMPLISHMENTS

An aerial reconnaissance was conducted to determine if, and where, any features resembling those formed due to liquefaction (e.g., sand blow, fissures, etc.) may exist south of known areas of liquefaction (i.e., south of Marked Tree, Arkansas). The aerial reconnaissance was divided into two areas of emphasis; (1) the area south of Interstate 40 between Brinkley and Marianna, Arkansas, and (2) the region between the St. Francis River and Interstate 55, and south of Marked Tree, Arkansas. Flight lines were oriented east-west for the Brinkley-Marianna area, and north-south for the region

east of the St. Francis River. The north-south flight lines were spaced about five to seven kilometers apart, while all of the Brinkley-Marianna area was surveyed. All features, which on appearance looked as if they may have had a seismic origin, were photographed, plotted on a map, and their latitude and longitude estimated using an onboard GPS system. The aerial reconnaissance was conducted two days following heavy rains that flooded much of the embayment and may have obscured more features.

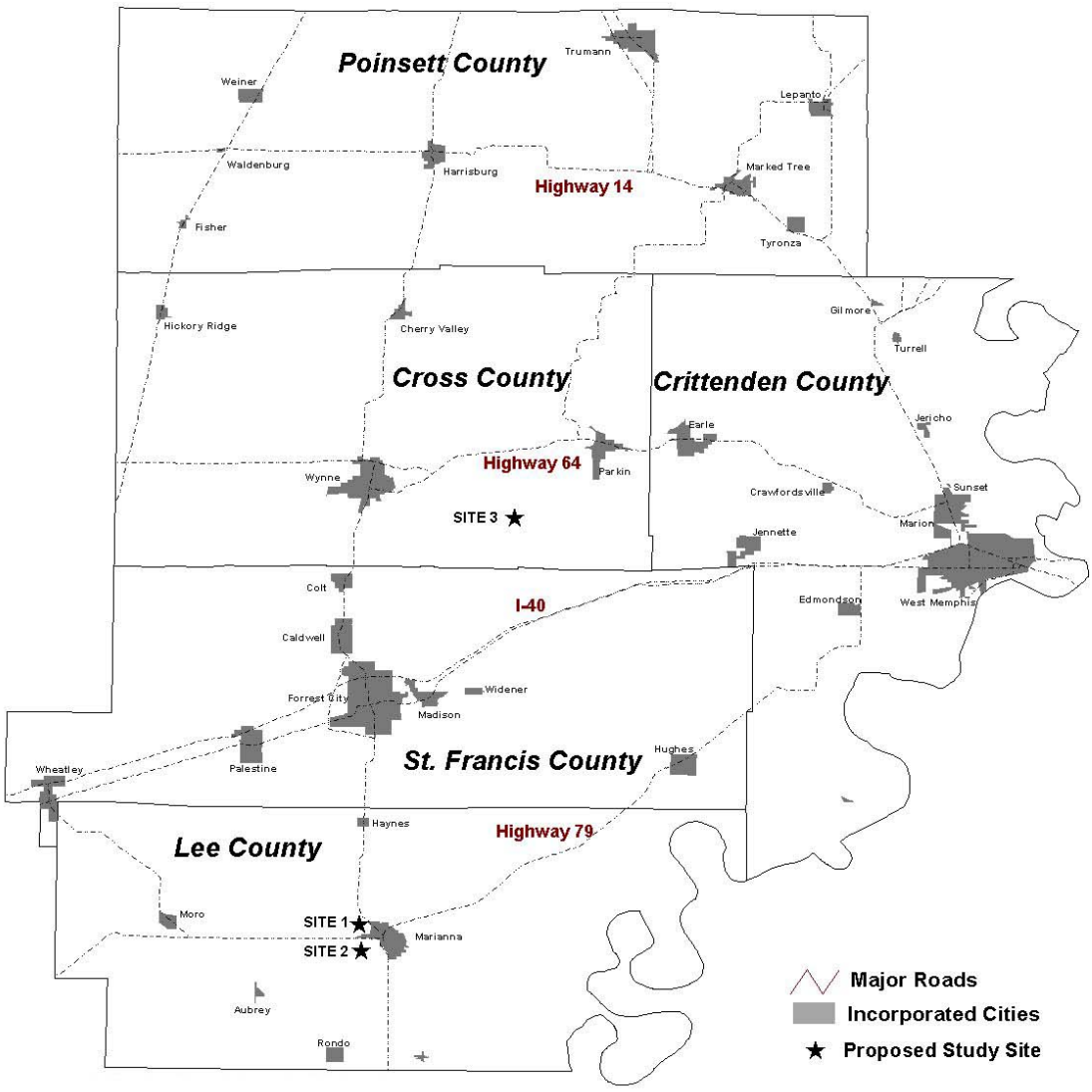

Figure 1. Site location map. Site 1 and 3 are the location sites for the trenches shown in the photographs in plate 1 and 2 respectively.

Figure 2. Aerial photograph showing the linear feature (see Figure 1 for location) that was trenched under this contract. Arrows indicate the location of the features and the solid line indicates the approximate location of the trench.

The Parkin site (Site 3 of Figure 1) is located in Cross County about eleven kilometers southwest of Parkin, Arkansas and four kilometers east of Crowley's Ridge. In aerial photographs (Plate 1), it can be seen as a linear feature with dark-colored, poorly drained soils to the northwest and lighter colored soils to the southeast that are relatively well drained (note the standing water to the south of the feature). There is also relief to this feature (note drainage rills perpendicular to the feature and flowing to the northwest and southeast). This linear feature is at least 1.5 kilometers long and trends N56ºE. The feature is approximately 2.75 meters higher than the land surface to the southeast. Additionally, a review of drill-hole data from area borings indicates that the elevation of the Paleozoic surface differs by about 100 to 110 meters on either side of the feature (Dart, 1992), indicating a possible fault in the subsurface.

A 95-meter trench was excavated normal to the lineament on October 5, 2000. The trench was dug to an average depth of 2.5 meters (Figure 3). Heavy rains flooded the site (rice field) and subsequently filled the trench with 1- 2 meters of water making detailed logging impossible. However, before the rain the trench was photo-logged and the walls cleaned and prepared for

logging. Our preliminary evaluation noted black clay comprising the northwestern 1/3 of trench overlying a yellowish-brown fine sand in the remaining trench exposure. The sandy unit is interbedded with several thin clay layers. The sand and the thin clay layers are diping a few degrees to the northwest. No surface faulting was observed in the trench. High resolution seismic and Ground Penetrating Radar data will be collected at this site during this fall and the coming winter.

Figure 3. A 95-meter trench dug normal to the linear feature shown in Figure 2.

The second site (Nancy 1, T-1) is located in Marianna, Arkansas (Figure 1, Site 1) and is an elliptically-shaped sandy area which on the surface measured 107m X 55m with the long axis

oriented N54ºW. A surface evaluation of the site revealed a silty sand (sandy loam) deposit that was about 1 meter thick near the feature's center and thinned towards the edges. The fine grained sandy deposit overlies a clay. Following initial site evaluation, a trench 75 meters long was excavated across the short axis of the feature in a N36ºE orientation. The average depth of the trench was 2 meters. Detailed logging confirmed a sand blow that resembles those in the immediate vicinity of the currently active segments of the New Madrid Seismic Zone. The sand blow deposit exceeded the length of the trench. Hand auguring, however, constrained its width to less than 125 meters. Exposed in the trench were no fewer than 45 sand dikes that extend from the trench floor to the sand blow deposit (Figure 5) cutting across several meters of clay. The sand dikes ranged in width from <1cm to 20 cm. In several areas of the trench, the sand blow deposit contained a loose sand overlying a hard cemented sand. These two sandy layers could represent one depositional episode with subsequent cementation of the lower layer by the leaching of minerals from above. Alternatively, there may have been two depositional episodes with the lower cemented sand the product of an earlier seismic event. Further work is needed to determine the cause of cementation. More work is scheduled during the fall at this site.

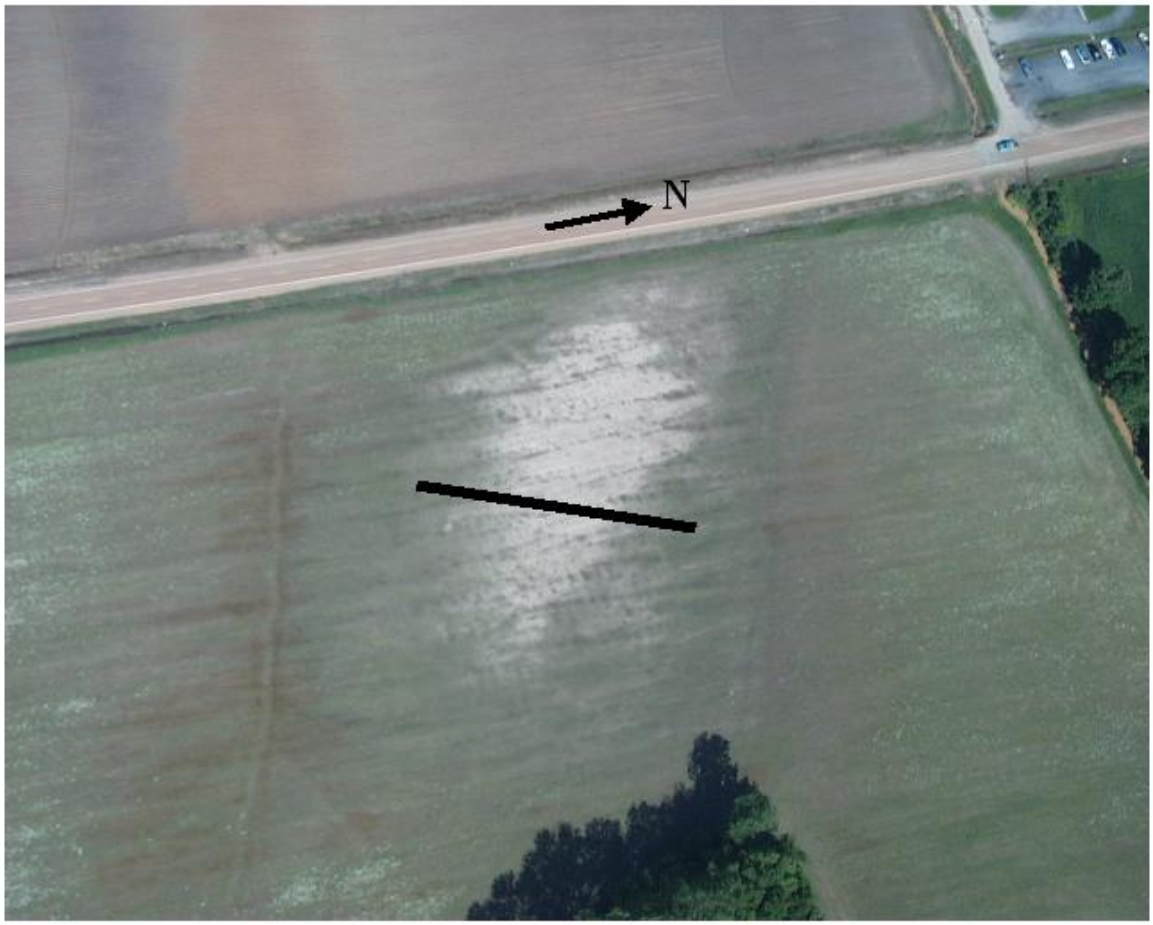

Figure 4. Aerial photograph showing the sand blow (Figure 1, Site 1) that was trenched under this contract. Solid line indicates the approximate location of the trench.

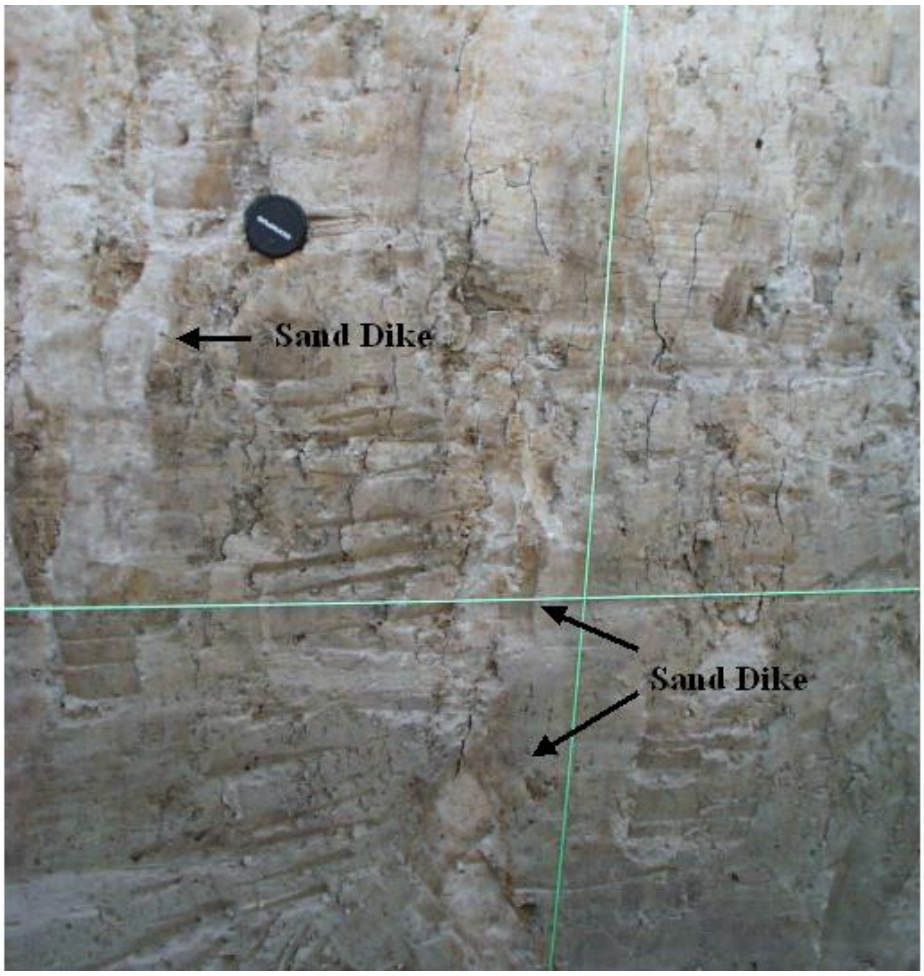

Figure 5. Sand dikes cutting through a thick clay layer. The dikes shown in this plate are few of more than 45 that were logged in the 75 meter trench that was excavated across the sand blow shown in Figure 4